Center Innovation Fund: JSC CIF

Paper-based Biosensor for Rapid Colorimetric Detection of Pathogenic Bacteria

Completed Technology Project (2012 - 2013)

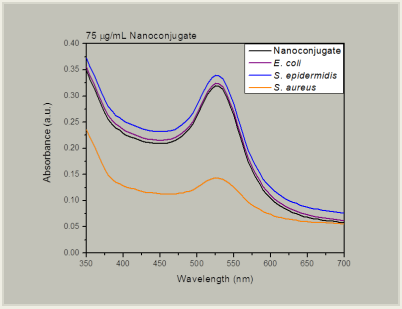
Project Introduction

The current project proposes to develop a real-time method for identification of targeted microorganisms using a paper-based biosensor system with ease-of-use, minimal requirement of time, and a simple interpretation of results imparted by colorimetric indication. To prove the feasibility of this approach, a binding target (ligand), specific for the bacterial pathogen, Staphylococcus aureus, will be attached to gold nanoparticle carriers (nanoconjugate), that are supported on a paper strip. Upon interaction with the bacteria, the nanoconjugates will aggregate, resulting in a color change on the paper. Due to the high sensitivity and specificity of the ligand, only the presence of S. aureus in a sample will result in a color change.

The ability to monitor microbial contamination remains a critical technique in the mitigation of risk to crew health and vehicle systems during human spaceflight missions. Current methods of bacterial and fungal monitoring on the International Space Station (ISS) depend on culturing of microorganisms during spaceflight and subsequent ground-based identification. This approach requires substantial crew time, uses consumables with short shelf lives, and prevents a rapid response to microbial contamination. To address these limitations for future missions beyond low-Earth orbit, a biosensor using gold nanoparticles is being developed for the rapid detection of medically significant microorganisms. For proof-of-concept, we have targeted the detection of Staphylococcus aureus, a common infectious agent that has been repeatedly isolated aboard the ISS. Gold nanoparticles were modified by the covalent attachment of an antibody that has a high binding affinity for a protein on the cell wall of S. aureus. Upon interaction with a sample containing S. aureus, binding between the nanoparticles and the bacteria occurred rapidly. A significant reduction in the red coloration of the colloidal nanoparticle suspension, and the formation of a large purple pellet was observed following a brief centrifugation step. Comparison of the absorbance spectra verified the visual observation, demonstrating that there was a significant reduction in the absorbance of the supernatants of reaction samples in which S. aureus was present. This biosensing system provides a rapid means to specifically detect only the targeted organism. Further development will potentially lead to a small, lightweight biosensor that can be easily adapted to detect other selected microorganisms in real-time, providing crews of future spaceflight missions a simple method to autonomously define potential infectious disease risks.

Anticipated Benefits

The expected technical outcome of this work will be an inexpensive, small, lightweight, disposable paper-based biosensor capable of real-time detection of *S. aureus*. The technology can possibly be expanded to target additional microorganisms in order to provide real-time microbial monitoring of spacecraft and crew. In addition, this technology could provide diagnostic



Project Image Paper-based Biosensor for Rapid Colorimetric Detection of Pathogenic Bacteria

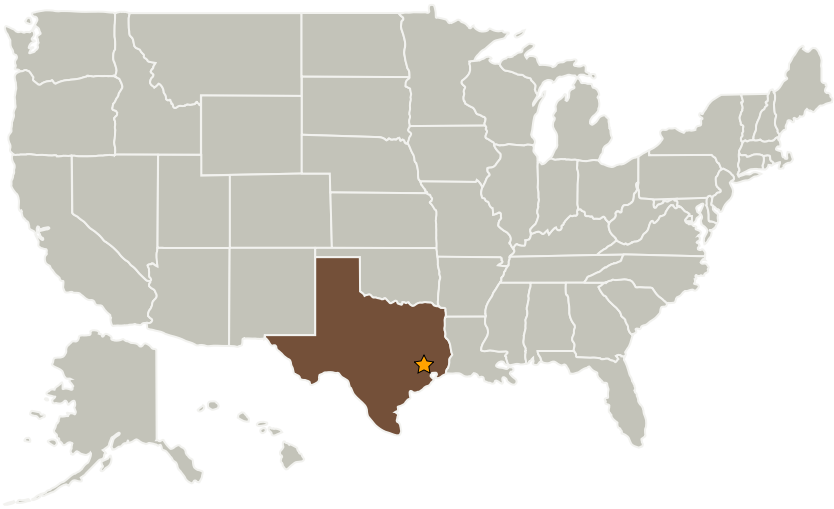
Table of Contents

Paper-based Biosensor for Rapid Colorimetric Detection of Pathogenic Bacteria

Completed Technology Project (2012 - 2013)

capabilities of bacterial associated infections.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Wyle Integrated Science and Engineering Group	Supporting Organization	Industry	

Primary U.S. Work Locations
Texas

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Center Innovation Fund: JSC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Carlos H Westhelle

Project Manager:

Charlie M Ott

Principal Investigator:

Sarah L Wallace

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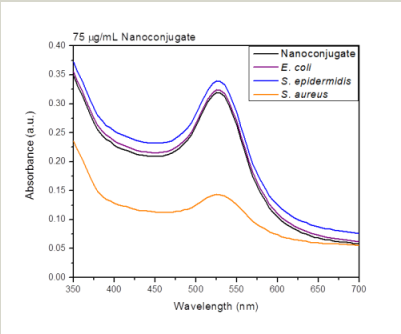
Images



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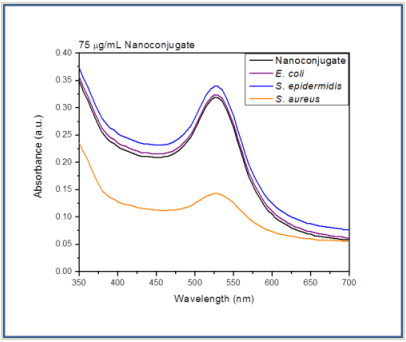
Project Image Paper-based Biosensor for Rapid Colorimetric Detection of Pathogenic Bacteria
(https://techport.nasa.gov/image/2244)



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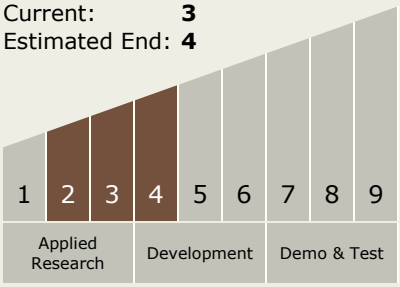
Project Image Paper-based Biosensor for Rapid Colorimetric Detection of Pathogenic Bacteria
(https://techport.nasa.gov/image/2245)

Links

NTR 1
(no url provided)

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.3 Human Health and Performance
    - TX06.3.1 Medical Diagnosis and Prognosis